COMPARISON OF THREE DIFFERENT SHUNTS DESIGN FOR AC-DC CURRENT TRANSFER

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Abstract: In order to update and improve INTI's AC-DC current transfer capabilities, we developed three different types of 5 and 10 A shunts for the AC-DC current transfer measurements included in a new AC-DC Transfer Step-Up scheme. The construction details and the measurements results are described in this paper.

Key words: AC-DC current transfer, current measurement, current shunts, thermal converters

1. INTRODUCTION

At Instituto Nacional de Tecnología Industrial (INTI), ac-dc current transfer measurement have been performed using thermalconverters (TVC) and shunts.

Thermalconverters reach current levels up to 10 mA. In order to increase the measurements capabilities, higher current thermalconverters [1] or low thermal current converters in combination with shunts are necessary.

The appearance in the market of new equipment capable of measuring high currents with high accuracy in a frequency range up to 100 kHz, creates the demand for calibration at these levels.

The INTI primary standards of the ac-dc current transfer difference consist of TVCs for lower currents (less than 100 mA) and TVCs combined with shunts for higher levels (100 mA to 10 A) [2]. The INTI's calibration and measurements capabilities in this field are from 3 mA to 10 A and in frequency are from 10 Hz to 100 kHz with uncertainties from 3 μV/V to 40 μV/V [3]. Although there are several commercial shunts available in the market, INTI decided to build their own. In this paper we are going to show some ac-dc current transfer difference results and three different designs for 5 A and 10 A shunts constructed and measured al INTI.

2. EXPERIMENTAL RESULTS

The shunts were characterized by measuring their ac-dc current transfer difference at 5 A, in a frequency range from 10 Hz to 100 kHz. The diagram of the measuring system can be seen in [4].

Fig.1 shows the ac-dc current transfer difference for three shunts measuring at 5 A. Two of them were design for 5 A and the other one was design for 10 A.

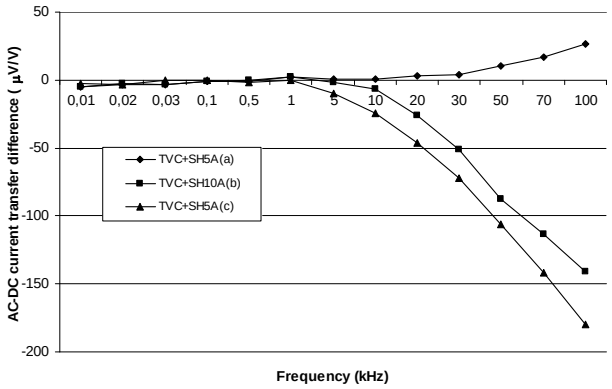

Fig.1: AC-DC current transfer difference at 5 A for three different shunt design.

3. DESIGN CONSIDERATIONS

All the shunts constructed at INTI were design for an output voltage of 1 V for nominal input current.

A diagram of the shunt identified as TVC+SH5A(a) can bee seen in Fig.2. The arrows indicated the flow of the current and the drop voltage in the resistors [5]

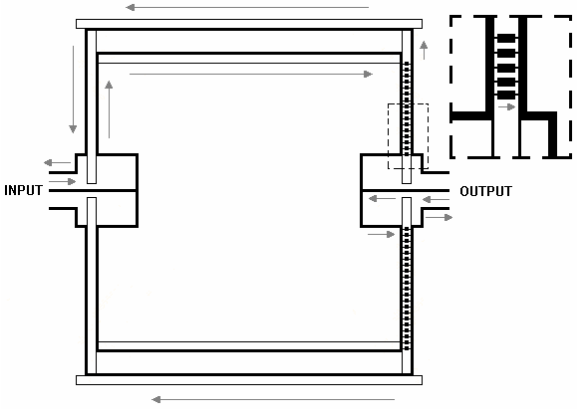

Fig.2: Details of the construction of 5 A shunt

In this case, surface-mount resistors (SMD) with values of 33 Ω were mounted in holes through the surface of the double-sided circuit board and soldered to the copper layers on both sides. The number of resistors was selected in order that the heat dissipation for each resistor was ¼ of the nominal power. This is to avoid level dependence errors due to the increase of the temperature with the increase of the input current. The resistors were placed in the perimeter of the circuit board to make the current distribution as symmetrical as possible. An UHF connector was placed in the middle of the circuit board (left side of Fig.2.) for the input current and an N male connector was placed for the output voltage (right of Fig.2).

The second design, identified as TVC+SH10A(b) can be seen in Fig.3. In this design, Vishay metal film resistors of 10 Ω with low temperature coefficient and low tolerance were used. The resistors were soldered between two plates.

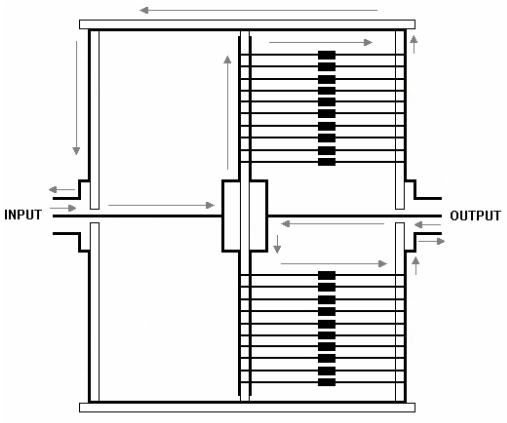

Fig.3: Details of the construction of 10 A shunt

The third design was used in the shunt identified as TVC+SH5A(c)) and can bee seen in Fig.4.

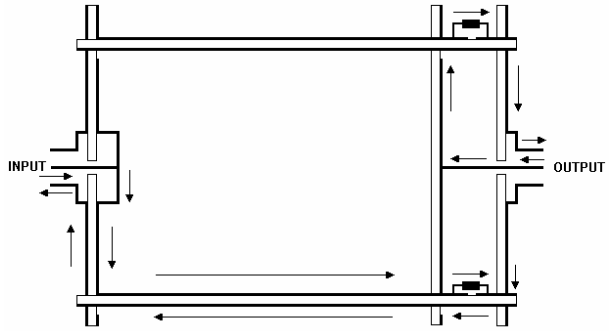

Fig.4: Details of the construction of 5 A shunt

This design is similar to the one used in the NMI of Russia and Sweden [6]. The shunt consists of 3 plates connected by ribs. The plates and the ribs are made of double side cooper layers. In the ribs, Vishay metal film resistors with nominal values of 10 Ω were soldered between the two output plates, connecting them in parallel. The arrows show the flow of current and the drop voltage in the resistors which is connected to the TVC.

3. CONCLUSION

Three different types of shunts used for ac-dc current transfer were measured. Results shows that the shunt identified as SH5 A(a) shows small ac-dc transfer difference in the hole range of measurements.

With this new set of shunts we can carry out multiple measurements in a same current range, that allow us have a redundant system, useful to obtain lower uncertainties through statistical tools.

Details analysis using lumped circuit of each type of shunt will be presented in the full paper.

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